ESTIMATION OF EXPOSURE OF PERSONS IN CALIFORNIA TO THE PESTICIDE PRODUCTS THAT CONTAIN

METHYL PARATHION

BY

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ABSTRACT

Methyl parathion is an organophosphate insecticide that was originally used as an emulsifiable concentrate or a microencapsulated formulation on a variety of fruits, vegetables, and grains in California. However, as of January 2000, the U.S. Environmental Protection Agency canceled methyl parathion uses on all fruit and a number of vegetable crops. It can now be used only on certain vegetables, small grains, and walnuts in California. In addition, only the microencapsulated formulation of methyl parathion is now registered in California. There were no illnesses reported from 2003 through 2007 that were attributed to methyl parathion exposure.

Occupational Exposures: Acute exposures to methyl parathion among pesticide handlers ranged from 15.5 µg/kg-day for ground boom applicators to 307 µg/kg-day for pilots. Acute exposures for reentry workers ranged from non-detectable amounts for walnut tree shakers operating closed cabs to 39.4 µg/kg-day for cotton scouts. The estimates of seasonal average daily dosages (SADD) ranged from 1.3 µg/kg-day for ground-boom applicators to 104 µg/kg-day for pilots. The SADD for field workers ranged from negligible for walnut tree shakers to 9.4 µg/kg-day for cotton scouts. Chronic exposures are not expected because the remaining label-approved uses of methyl parathion will not involve applications of the pesticide for extended periods of time.

Non-occupational exposures: Acute (single day) and intermediate (seasonal) exposures of adult males, adult females, infants (6 months), and children (3-5 years) were estimated based on the concentrations of the methyl parathion and methyl paraoxon in the air and the inhalation rates for each subgroup. The estimated acute exposures to application site ambient air levels of methyl parathion for an adult male, an adult female, an infant (6 months), and a child (3-5 years) living next to a treated walnut grove are 0.93, 0.76, 2.59, 2.02 µg/kg-day, respectively. Potential acute exposures to methyl paraoxon to those same individuals at the same location were 0.061, 0.051, 0.172, and 0.134 $\mu g/m^3$, respectively. Community ambient air levels were derived from towns near rice fields that had been treated with methyl parathion. Acute exposure in a community to ambient air levels of methyl parathion was estimated to be highest in the town of Maxwell, with adult males, females, infants, and children (3-5) being exposed to 6.3, 5.2, 17.6, and 13.7 ng/kg-day, respectively. Seasonal exposures of people living in towns or next to the application sites were estimated to be 1.8, 1.5, 5, and 3.9 ng parathion/kg-day, respectively. Annual exposure to airborne methyl parathion is not expected since airborne concentrations reach background levels within a few days after the application, and only a few repeated applications can be made to a crop during a season due to label restrictions (not more often than every 14 days).

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I. Introduction

Methyl parathion is currently registered as an insecticide for agricultural uses in California. There are no residential or domestic uses. As stated in the California Food and Agriculture Code, Sections 11501, 12824, 12825, 12826, 13121-13135, 14102, and 14103, the Department of Pesticide Regulation (DPR) is charged with protecting individuals and the environment from the potentially adverse effects of pesticide use in California. As part of the Department's effort to meet this mandate, pesticide active ingredients are prioritized for assessment of exposure and risk potential (DPR, 2004). On the basis of this prioritization process, selected pesticide active ingredients are subjected to a comprehensive risk assessment where the evaluation is conducted in accordance with the California Code of Regulations, Title 3, Section 6158. DPR is currently preparing a risk characterization document for methyl parathion because animal toxicity studies have shown that it can cause inhibition of cholinesterase activity resulting in cholinergic signs and neurobehavioral effects. This human exposure assessment document was prepared in order that the risks of exposure to methyl parathion can be characterized. The exposure values from this document will be incorporated into the DPR comprehensive Risk Characterization Document. This document may also serve as a basis for developing mitigation strategies should the estimated exposure be calculated to result in excessive risk.

II. Chemical/Physical Properties

Methyl parathion, CAS # 298-00-0, is the common name for O, O-dimethyl O-(4-nitrophenyl) phosphorothioate. It has an empirical formula of $C_8H_{10}NO_5PS$ with a molecular weight of 263.2. Methyl parathion is a white crystal that melts at 35 to 36 °C. It has a vapor pressure of 1.7×10^{-5} mmHg at 25 °C (Spencer *et al*., 1979) and an octanol-water partition coefficient (K_{ow}) of 629 at 25 °C (Kabler, 1998). It is practically insoluble in water (50 ppm) but readily soluble in most organic solvents. Methyl parathion is an organophosphate that can cause cholinesterase inhibition.

III. Federal Regulatory History

In 1986, the United States Environmental Protection Agency (U.S. EPA) issued guidance for the re-registration of products containing methyl parathion. In this guidance, the Agency decided not to conduct a special review for methyl parathion for several reasons, including inadequate exposure data available to evaluate risk. However, the Agency decided to review the data submitted in response to this guidance to determine if a special review was warranted at a later time. The restricted use pesticide classification was retained. In addition, the Agency required human exposure and biological monitoring data since the exposure data in files were inadequate to conduct an exposure assessment.

On August 2, 1999, the U.S. EPA announced major changes in the registration of methyl parathion. The changes resulted from reviews that were conducted pursuant to the Food Quality Protection Act (FQPA). Effective January 2000, labels allowing use of methyl parathion on fruit

trees, certain vegetables, and ornamentals were canceled. In addition, U.S. EPA increased the restricted entry intervals (REI) from two days to five days, and asked the manufacturers to submit additional worker exposure studies.

IV. Formulations

As of November 2005, the only formulation registered in California is a microencapsulated formulation. Penncap-M® is a flowable microencapsulated (M.E.) formulation containing 20.9 percent active ingredient (a.i.) or two pounds (lb) a.i. per gallon. It is a water-based suspension of capsules averaging 20 to 30 microns in diameter.

V. Usage

Methyl parathion is an insecticide that is registered for use on alfalfa, almonds, barley, beans, cabbage, canola, corn, cotton, hops, oats, onions, pecans, potatoes, rice, rye, sugar beets, sunflowers, and wheat. The Section 3 label does not carry a registered use for walnuts, but the label does refer to a special local needs label for walnuts. The Penncap-M® special local need (SLN) label for use on walnuts in California has a maximum application rate of 2.0 lb a.i./acre. Cotton use is considered minor in California. Methyl parathion may be applied by air or ground equipment, and can be diluted with sufficient water to be suitable for the specific crop and type of application equipment. Its use through any type of irrigation system is prohibited. The rates of application are 0.25 to 0.75 lb a.i./acre for rice, and 0.25 to 1.0 lb a.i./acre for small grains. The maximum application rates on cotton are 1.0 lb a.i./acre. Table 1 shows the use of methyl parathion from 2004 to 2008. At the present time, greater than 96% of the use of methyl parathion is on walnut trees.

Table 1. **Methyl Parathion Use Report in California During 2004 to 2008.**

	2004		2005		2006		2007		2008	
Commodity	pounds	%	pounds	%	pounds	%	pounds	%	pounds	%
Walnuts	66,000	92	77,000	97	84,000	99	74,000	99	32,000	94
Other	6,000	8	2,000	3	1,000	1	1,000	1	2,000	6
Total	72,000	100	79,000	100	85,000	100	75,000	100	34,000	100

a/ (DPR, 2010)
b/ Rounded off to nearest thousand.

VI. Label Precautions and Regulatory Requirements

Methyl parathion is a restricted use pesticide due to very high acute toxicity to humans and birds. Thus, retail sale and use is restricted to certified applicators or persons under their direct supervision. Penncap-M® is a toxicity category II pesticide bearing "Warning" as a signal word. The precautionary statement on the product label describes the hazards that could result from ingestion, inhalation, or dermal contact with methyl parathion. The Penncap-M® label does not allow human flaggers.

The Penncap-M® label lists a restricted entry interval (REI) of five days (four days in areas with an annual rainfall of 25 inches or more) for all crops. Based on the California Code of Regulations (CCR) Section 6774(e), the REI of 5 days is used in California. The pre-harvest intervals (PHI) on Penncap-M® label range between 5-20 days, depending on the crop and rate of application. The PHI for walnuts is 14 days.

The following PPE is required by the label when mixing/loading, applying, repairing, cleaning application equipment, and disposing of the pesticide:

- Coveralls over long-sleeved shirt and long pants.
- Chemical resistant gloves.
- Chemical resistant footwear plus socks.
- Protective eyewear.
- Chemical resistant head gear.
- For outdoor exposures, dust/mist filtering respirator (MSHA/NIOSH approval number prefix TC-21C) or a NIOSH approved respirator with any N, R, P, or HE filter.
- For exposure in enclosed areas, a respirator with an organic-vapor removing cartridge with a pre-filter approved for pesticides (MSHA/NIOSH approval number prefix TC-23C), or a canister approved for pesticides (MSHA/NIOSH TC-14G), or a NIOSH approved respirator with an organic vapor cartridge or canister with any N, R, P, or HE pre-filter.

When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the Worker Protection Standard for agricultural pesticides (40CFR 170.240(d)(4-6)), the handler PPE requirements may be reduced or modified as specified. All other PPE required for use during the application must be worn when exiting the cab into treated areas.

During aerial application, human flaggers are prohibited. PPE required for early entry is: coveralls over long-sleeved shirt and long pants, waterproof gloves, chemical-resistant footwear and socks, protective eyewear, and chemical-resistant headgear.

VII. Worker Illnesses

California Health and Safety Code requires that any illness suspected of being caused by a pesticide be reported by the examining physician to the county health officer within 24 hours (Section 105200 of the Health and Safety Code). Review of these cases by the Pesticide Illness Surveillance Program of DPR (www.cdpr.ca.gov/docs/whs/pisp.htm) indicated that there were no illnesses reported from 2003 through 2007 that were attributed to methyl parathion exposure.

VIII. Dermal Sensitization

No sensitization was observed in guinea pigs treated topically with methyl parathion (Cuthbert and Carr, 1986). Methyl parathion (80% technical) was tested on the shaved flank of 20 guinea pigs that had previously been exposed to paraffin oil as the vehicle. No positive reactions were observed in any of the tested animals following a topical application.

IX. Human Metabolism

A human pharmacokinetic study indicated that the recovery of *p*-nitrophenol (conjugated and unconjugated), following ingestion of 2 or 4 mg of non-radiolabeled, methyl parathion, averaged 27% in a 24-hour collection from four adult males (Morgan *et al.*, 1977). Urine samples were collected every four hours, and the levels of *p*-nitrophenol and other metabolites of methyl parathion were determined. The average recovery of *p*-nitrophenol from 17 spiked urine samples was 76±11%. Urinary levels of *p*-nitrophenol peaked in the first 4-hour collection, reaching baseline low levels after the second 4-hour collection. Although this study examined a number of different metabolites of methyl parathion in the urine, the biological monitoring studies mentioned later in this exposure assessment only reported on levels of *p*-nitrophenol in the urine of agricultural workers.

X. Dermal Absorption

A study was conducted to determine dermal absorption of methyl parathion in male Sprague-Dawley® rats (Sved, 2001). The animals were about nine weeks old and the body weights ranged from 242 to 269 grams. Methyl[ring-U-^{14}C] parathion was prepared in acetone for dosing at 1.03 μg/cm^2 (actual low dose) and 11.6 μg/cm^2 (actual high dose). The dosing solution was applied to the skin inside an "O"-ring attached to the animals. The treated skin site was covered with an occlusive, circular-cut piece of X-ray film glued to the O-ring. Five animals were used for each dose. At 10 hours after dosing, the dose site was washed four times: twice with gauze soaked in dilute detergent (Dove Dishwashing Detergent : deionized water, 1:50) and twice with gauze soaked in deionized water. The animals were sacrificed at 96 hours post-dosing. The mean dermal absorption values (adjusted to reflect 100% recovery) were 96% for the low dose and 95% for the high dose (Thongsinthusak, 2003b; Thongsinthusak, 2003a).

Sartorelli *et al*. (1977) studied *in vitro* dermal penetration of a commercial formulation of methyl parathion through the human skin. Methyl parathion dissolved in acetone and methyl parathion in the form of a 20% commercial formulation (type of formulation not identified in the report) were used in a static diffusion cell system. Full-thickness abdomen skin from a human cadaver was used as the membrane. Three cells were used for each form of methyl parathion. The results showed mean lag time of less than eight hours for methyl parathion in acetone and less than three hours for the commercial formulation. At 24 hours, 1.4 ± 0.8% and 5.2 ± 1.5% of the applied dose of methyl parathion in acetone and the commercial formulation, respectively, penetrated the skin. Percutaneous penetration was 3.6 ± 1.8% and 9.0 ± 2.4% in 48 hours for methyl parathion in acetone and the commercial formulation, respectively.

There are *in vivo* human dermal absorption studies for ethyl parathion, a pesticide that is chemically similar to methyl parathion. Feldmann and Maibach (Feldmann and Maibach, 1974) applied ^{14}C-labeled ethyl parathion to the forearms of 6 human volunteers and quantified the urinary excretion of ^{14}C. ^{14}C-ethyl parathion was applied to the ventral surface of the forearms at a dose of 4 μg/cm^2. The dose was dissolved in a small amount of acetone and applied to the skin. The acetone was evaporated by gently blowing on the surface during the application. The

application sites remained unoccluded. The volunteers were advised not to wash their forearms for 24 hours. Urine samples were collected for five days at three four-hour intervals followed by a 12-hour interval during the first day and every 24 hours for the remaining four days. Samples were analyzed by wet washing 5 mL of the urine, and trapping all of the carbon as carbon dioxide (CO_2) in ethanolamine. The trapped CO_2 was diluted and counted with a scintillation counter. The results were corrected for urinary excretion (45.8%) following an intravenous dose. Total five-day excretion was 9.7 $\pm$ 5.9% of the administered dose.

There is reason to believe that the *in vivo* rat dermal absorption of methyl parathion (96%) is an overestimate of human dermal absorption. Ethyl parathion, chemically very similar to methyl parathion, exhibited an *in vivo* dermal absorption rate of 95% in the adult rat (Shah *et al.*, 1987). Yet, as noted above, studies indicate human dermal absorption of ethyl parathion to be only 10% on those portions of the anatomy most likely to come in contact with the chemical (Feldmann and Maibach, 1974). One would expect a similar relationship between the percentage dermal absorption in rats and humans for methyl parathion. Consequently, it was decided to use the Worker Health and Safety default rate of 50% dermal absorption (Donahue, 1996).

XI. Exposure Estimates

A. Handlers

Mixing/Loading for Aerial Application. The work task identified as having potentially the greatest exposure to methyl parathion was mixer/loaders working with aerial applications. Two biomonitoring studies were submitted which examined this scenario. The formulation used in both studies was Penncap-M®. In each biomonitoring study, the workers were housed in a motel for 2 days prior to exposure to methyl parathion in the study. Four 12-hour urine samples were collected during this time. Six 12-hour urine samples were collected continuously during the 72 hours of the exposure (single day) and subsequent two days. The human pharmacokinetic study (Morgan *et al.*, 1977), however, only examined urinary output for 24 hours after exposure. Consequently, only the amount of p-nitrophenol in the urine during the 24 hours prior to exposure was used as the baseline. Only the first two 12-hour urine samples collected after exposure were used for estimating exposure. The baseline values were subtracted from the exposure values. The final value was then corrected for fact that only 27% of the metabolite is excreted in the first 24 hours. Calculation of the absorbed daily dose utilized the following formula:

$$ADD = M * V * R/BW$$

Where: ADD = Absorbed Daily Dose (µg/kg-day)
M = concentration of *p*-nitrophenol in urine (µg/L)
V = urinary volume (L)
R = ratio of molecular weights of methyl parathion and *p*-nitrophenol (7)
BW = body weight (kg)

The first study involved operations at 5 sites, Greenville, MS; Gila Bend, AZ; and Harquahala, AZ (Rotondaro, 2001), as well as in Louisiana and Arkansas (Willard, 2001). Although the maximum application rate (1 lb a.i./acre) was used, the amount mixed was dependent upon the aircraft used (Appendix I). In Mississippi, an 80-gallon mixing tank was used with an Air Tractor (model AT402) airplane (400 gallon capacity). At the Arizona sites, a 150-gallon mixing tank was used with an Ayers (SR2N) airplane (500 gallon capacity). An Air Tractor (model AT502) airplane (500 gallon capacity) was used in Louisiana and Arkansas. Only 360 acres were treated in any of the trials (Appendix I, Tables I-1, I-2). Workers at Greenville, MS and Gila Bend, AZ wore the label-prescribed PPE [a long-sleeved shirt, long pants underneath coveralls, water proof gloves, socks and boots, protective eyewear, and a dust/mist filtering respirator] while mixing and loading. In addition to the PPE on the label, workers at Harquahala, AZ wore a full-face shield (in place of goggles), apron and chemical resistant headgear (Tyvek® rain hat). Mixer/loaders in Arkansas and Louisiana wore chemical resistant aprons and head gear, full face shields, and a dust/mist filtering respirator (NIOSH approval number prefix TC-21C) in addition to the label-required PPE. Cleanup procedures for all 5 sites included rinsing of the mixing tanks, disposal of empty test substance containers and caps; at the MS site cleanup also included washing the aircraft. Urine samples were collected for 48 hours prior to and after exposure. Twelve-hour urine samples were collected. Only the samples collected during the 24 hours before working, and the 24 hours during and following exposure were used. All workers' samples were included even though the worker activities varied. Assuming linearity, the calculated exposure of mixer/loaders (n=26) for aerial applications to 1000 acres/day (Haskell, 1998) averaged 29.6 µg/kg-day with a standard deviation of 25.7 µg/kg-day.

Five air-monitoring samples were collected at Harquahala, Arizona to help define the inhalation route of exposure. Pumps drew air samples from the breathing zone through OVS (OSHA Versatile Sampler) tubes for each of 5 mixer/loaders during the 2-hour work cycle at 2 L/min. There were technical difficulties with 1 sample. Three of the five samples had less than 0.05 µg, the limit of quantitation. (The limit of quantitation [LOQ] determined in field fortification samples was <0.05 µg/240L, or <0.21 µg/m^3.)

[Quantitation limits arise from two distinct needs (Helsel, 2005). First, a threshold needs to be established above which reliable single numbers can be reported. These are generally computed at about 10 times the standard deviation of a low standard such as the one used to define the method detection limit. A concentration 10 times the background variability is considered large enough by most chemists that a single number might be comfortably reported. The result is a threshold that is a little over 3 times the value of the detection limit.

Second, a threshold is established that protects against false negatives. A false negative occurs when a measurement whose true concentration is at or above the detection limit is reported.]

The fifth sample had 0.0822 µg, indicating an air concentration of 0.34 µg/m^3. Assuming that an adult male weighing 77 kg inhales at a rate of 1.0 m^3/hr during light activity (Thongsinthusak, 1998), the theoretical absorbed dose acquired by inhalation can be calculated as follows:

Absorbed dose = AC x BR x hr x 1.0 / BW = 0.02 µg/kg-day

Where: AC = average concentration = (0.34 + [3 x ½ LOQ])/4 = 0.24
BR = breathing rate = 1.0 m^3/hr
Hr = hours worked = 6
1.0 = 100% retention and 100% absorption of methyl parathion vapor
BW = average body weight of adult male = 77 kg

Thus, the average absorbed dose through the inhalation route (0.02 µg/kg-day) would be less than 0.1% of the total average absorbed dose (29.6 µg /kg-day) determined by calculation from biomonitoring data. Consequently, inhalation exposures were considered insignificant and not included in the calculation of absorbed dose.

Ground-boom Applicators. Biomonitoring of ground-boom applicators applying methyl parathion to potatoes was conducted in Florida, Washington and Wisconsin (Belcher, 2001a). The applicators did not assist in the mixing or loading of Penncap-M® into the spray equipment. Applications were made using an open-cab tractor and ground boom application equipment calibrated to deliver 1.5 pounds of active ingredient per acre. Each applicator sprayed several tank loads to treat approximately 200 acres, which took 7-12 hours to complete. Between loads, and during mixing/loading, the applicator either remained seated on the tractor or took a short break to eat, drink water, rest, or urinate. Applicators checked connections on the sprayer, adjusted sprayer flow rates, adjusted the boom, unclogged nozzles, and completed other repairs. Applicators wore coveralls over long-sleeved shirts and long pants; waterproof gloves; chemical-resistant footwear plus socks; protective eyewear; chemical-resistant headgear; and a dust/mist filtering respirator. Urine samples were collected for 48 hours prior to and after exposure. Twelve-hour urine samples were collected. Only the samples collected during the 24 hours before working, and the 24 hours during and following exposure were used. The baseline values were subtracted from the exposure values. The calculated average exposure of 15 applicators was 14.3 µg/kg-day with a standard deviation of 16.2 µg/kg-day. Assuming linearity, this was normalized to the California situation, that was assumed to be 100 acres treated in a day (Haskell, 1998) at 1 pound a.i./acre, or 4.8$\pm$5.4 µg/kg-day.

For acute exposure estimates, the biological monitoring data was assumed to be log-normal in distribution (Frank, 2009). The 95th percentile population upper-bound was calculated from the data and used to represent the acute exposure unless there was a measured value in excess of the upper-bound. In those instances where the upper-bound was superseded, the highest measured value was used to represent the acute exposure number (Frank, 2009).

Surrogate Exposure Data. Neither biomonitoring data nor chemical-specific passive dosimetry data were available for pilots, ground mixer/loaders, or air blast applicators. Consequently, the estimates of exposure for these work tasks were based on surrogate data. Generic pesticide exposure data from the Pesticide Handlers Exposure Database (PHED) presented in Appendix II (Versar, 1992) was used to estimate the exposures of pilots and ground mixer/loaders. It was assumed that the mixer/loaders wore the personal protective equipment specified on the label (coveralls over long-sleeved shirt and long pants; chemical resistant gloves; chemical resistant footwear plus socks; protective eyewear; chemical resistant head gear; dust/mist filtering

respirator) when handling the concentrate. Pilots and air blast applicators were also assumed to be wearing the label-specified PPE (described above). As there were no data in PHED specifically associated with microencapsulated formulations, exposures to liquid formulations were used as surrogates. Pilots were assumed to use open cockpits, wearing the label-specified PPE. Pilots were assumed to be able to spray up to 500 acres/day (Haskell, 1998). It was assumed that mixer/loaders for ground operations would use open systems, wearing the label-required PPE. Mixer/loaders for ground operations were expected to be able to service two airblast applicators/day. Airblast applicators were assumed to treat 50 acres/day (Haskell, 1998).

Surrogate exposure data for airblast applicators came from a more recent source than PHED (Smith, 2005). Carbaryl was applied in three orchard crops (peaches, apples, and citrus) in three states (Georgia, Idaho, and Florida). Applicators drove open-cab tractors and wore either Sou'wester rain hats (15 replicates) or hooded rain jackets (10 replicates) as chemical-resistant headgear; because the jackets provided an extra layer of clothing over the torso and arms, only data from the replicates wearing rain hats were used to estimate exposure. Exposure monitoring results for airblast applicators wearing Sou'wester rain hats are summarized in Table 2. Dermal exposure was monitored with whole-body dosimeters, face/neck wipes, hand washes and patches on the inside and outside of headgear. Inhalation exposure was monitored with breathing zone air samplers consisting of OSHA Versatile Sampler tubes, each containing glass fiber filter and XAD-2 sorbent and connected to a sampler pump calibrated to 2 liters per minute. Applicators were monitored for 5 – 8 hours each, which is about the length of a typical workday for them. Actual spray times ranged 3.3 – 5.7 hours; applicators handled 24 – 90 pounds AI (11 – 41 kg), and treated 12 – 30 acres (5 – 12 ha). Quality assurance samples consisted of laboratory control samples of each matrix, laboratory-fortified samples of each matrix, and field fortified samples of each matrix. Field fortifications (FFs) consisted of each sample matrix spiked with formulated product, and with the exception of socks all FF recoveries were in the acceptable range (70 – 120%). Results were corrected for FF recoveries below 90%.

Table 2. Exposure of Open-Cab Airblast Applicators to Carbaryl [a]

	Exposure Rate (µg AI/lb handled)
Dermal Exposure	
Arithmetic Mean	73.7
Standard Deviation	65.4
95th Percentile [b]	277
Inhalation Exposure	
Arithmetic Mean	3.41
Standard Deviation	3.65
95th Percentile [b]	9.54

[a] Summary of data from open-cab airblast exposure monitoring study (Smith, 2005). Only the 15 replicates wearing Sou'wester rain hats were included; product labels require chemical-resistant headgear. Arithmetic mean exposure rates were used to calculate long-term exposures and 95th percentile exposure rates were used to calculate short-term exposures. All estimates were rounded to three significant figures.

[b] 95th percentile estimates calculated in Excel, assuming a lognormal distribution. First the natural logarithm (ln) was calculated for each value using the LN function; arithmetic mean (am) and standard deviation (asd) was then calculated for the natural logarithms (am(lns) and asd(lns), respectively). The NORMSINV function, with a probability of 0.95, was used to get the inverse of the standard normal cumulative distribution, which was multiplied by asd(lns). This result was added to am(lns), and the sum taken as the power of e with the EXP function.

Airblast applicators using methyl parathion were assumed to use open cabs, wearing the label-required PPE. The net effect of the required PPE is to reduce the dermal exposure from each of the scenarios by 90% (Appendix II). The current Worker Health and Safety Branch (WHS) standard practice while utilizing PHED exposure estimates, is to use the 90% upper confidence limit on the 95th percentile for acute exposures to account for uncertainty inherent in using surrogate data (Frank, 2007). Seasonal exposure estimates use the arithmetic average of PHED data. Exposures from both the dermal (Table 3) and inhalation (Table 4) routes were calculated. The absorbed dosages through each of the routes are shown in Table 5. Estimates of exposure based on biological monitoring data, derived from urinary excretion of pesticide metabolites, necessarily combine the absorbed dosages through all routes.

Table 3. Methyl Parathion Handlers' Estimated Acute and Average Daily Dermal Exposure From PHED and Surrogate Data.

Work Task	Acute Dermal Exposure (µg/lb a.i.)	Daily Use lb a.i.[a]	Acute Daily Dermal Exposure (µg/day)	Avg. Dermal Exposure (µg/lb a.i.)	Daily Use lb a.i.[a]	Avg. Daily Dermal Exp. (µg/day)
Pilot (open cockpit)[b]	88.8[c,d]	500	44,000[e]	29.6[c]	500	15,000[e]
Ground mixer/loader[b]	406[c,d]	100	41,000[e]	102[c]	100	10,000[e]
Airblast applicator[b]	277[f]	50	14,000[e]	73.7[f]	50	4,000[e]

a/ Based on pilot, ground mixer/loader, and airblast applicator treating a maximum of 500, 100, and 50 acres in an 8-hour workday, respectively (Haskell, 1998) at an application rate of 1 lb of a.i./acre.
b/ Corrected for label PPE requirement of a closed cab or coveralls, gloves, shoes, headgear, and eyewear for ground applicators (providing 90% exposure protection).
c/ Data from PHED calculations (Appendix II).
d/ 90% upper confidence limit of the 95th percentile data from PHED were used for acute exposure.
e/ Rounded to nearest thousand.
f/ Dermal data from Smith (Smith, 2005).

Table 4. Methyl Parathion Handlers' Estimated Acute and Average Daily Inhalation Exposure From PHED and Surrogate Data.

Work Task	Acute Inhal. Exposure (µg/lb a.i.)	lb a.i.[a]	Acute Daily Inhal. Exposure (µg/day)	Avg. Inhal. Exposure (µg/lb a.i.)	Daily Use lb a.i.[a]	Avg. Daily Inhal. Exp. (µg/day)
Pilot (open cockpit)[b]	2.9[c,d]	500	1,450	1.2	500	600
Ground mixer/loader[b]	0.8[c,d]	100	80	0.2	100	20
Airblast applicator[b]	9.5[d,e]	50	475	3.4	50	170

a/ Based on pilot, ground mixer/loader, and airblast applicator treating a maximum of 500, 100, and 50 acres in an 8-hour workday, respectively (Haskell, 1998) at an application rate of 1 lb of a.i./acre.
b/ Corrected for label PPE requirement of a closed cab or coveralls, gloves, shoes, headgear, and eyewear for ground applicators (providing 90% exposure protection).
c/ Data from PHED calculations (Appendix II).
d/ 90% upper confidence limit of the 95th percentile data from PHED were used for acute exposure.
e/ Inhalation data from Smith (Smith, 2005).

Table 5. Methyl Parathion Handlers' Estimated Absorbed Daily Dosage (ADD) and Seasonal Average Daily Dosage (SADD) Using Biological Monitoring Data, Pesticide Handlers Exposure Database (PHED), and Surrogate Data.

Work Task	Acute Daily Dermal Exposure (µg/day)	Acute Daily Inhal. Exposure (µg/day)[a]	ADD[a] (µg/kg-day)	Avg. Daily Dermal Exp. (µg/day)	Avg. Daily Inhal. Exp. (µg/day)	SADD[b] (µg/kg-day)
Mixer/loader (aerial)	-	-	26.4[c]	-	-	5.8[d]
Pilot (open cockpit)[e]	44,000	1,450	307[e]	15,000	600	104[e]
Ground mixer/loader[e]	41,000	80	265[e]	10,000	20	66[e]
Airblast applicator[e]	14,000	475	96[e]	3,700	170	26[e]
Ground boom applicator	-	-	15.5[c]	-	-	1.3[d]

a/ Absorbed daily dose (ADD).

b/ Seasonal absorbed daily dose (SADD).

c/ Represents the highest measured value as it is greater than the 95th percentile upper-bound exposure calculated from biological monitoring studies data for mixer/loaders and applicators wearing work clothing, coveralls, gloves, shoes, headgear, eyewear, and respirator during application (Frank, 2009). Uses actual body weights of workers in the studies.

d/ Calculated from biological monitoring studies data for mixer/loaders and applicators wearing work clothing, coveralls, gloves, shoes, headgear, eyewear, and respirator during application. Uses actual body weights of workers in the studies. Represents the arithmetic average exposure.

e/ Calculated from PHED data by adding the absorbed dose through the dermal route to the absorbed dose through the inhalation route. Assumes a body weight of 77 kg (Thongsinthusak, 1998), 50% dermal absorption, and 100% inhalation retention/absorption.

B. Re-entry Workers

Cotton Scouts. Biomonitoring of cotton scouts was conducted in California, Louisiana, and Texas (Willard, 2000a). Treated plots received four ground spray applications of Penncap-M® each at a rate of 1.0 lb a.i./A. Applications were made at 5-day intervals, with the fourth application 4 days prior to scouting in Louisiana and Texas and 5 days prior to scouting in California. All workers had previous experience as cotton scouts, and wore underwear, long pants, undershirt, long-sleeved shirt, socks and closed shoes. None wore protective gloves. A scouting cycle was 1 hour in duration, with 45 minutes in the field and 15 minutes out of the field. Hands were washed with soap and water if break activities included consumption of liquids or bathroom breaks. The full-day work cycle consisted of 6 scouting cycles. Urine samples were collected for 48 hours prior to and after exposure. Twelve-hour urine samples were collected. Only the samples collected during the 24 hours before working, and the 24 hours during and following exposure were used. The baseline values were subtracted from the exposure values. The calculated average exposure to cotton scouts (n=15), normalized to an 8-hour workday (8 scouting cycles), was 9.4 µg/kg-day with a standard deviation of 9.7 µg/kg-day. Cotton scouts were assumed to work for a total of 21 days/year (Meinders and Krieger, 1988). That amount of time constitutes about 6% of the year, and does not justify chronic exposure.

Corn Harvesters. Biomonitoring of sweet corn harvesters was conducted in Florida (Willard, 2000b). Treated plots received four aerial spray applications of Penncap-M® each at a rate of

0.75 lb a.i./A. Applications were made at 3-day intervals, with the fourth application 4 days prior to sweet corn hand harvesting. Workers were provided with new clothing (long pants, undershirt, long-sleeved shirt, socks, and underwear) to wear during sweet corn harvesting. All workers wore closed shoes; some wore hats, but none wore protective gloves. There were approximately 5.6 hours of in-field exposure. The total time from the beginning of exposure until the workers removed work clothing was 8.5 hours. Urine samples were collected for 48 hours prior to and after exposure. Twelve-hour urine samples were collected. Only the samples collected during the 24 hours before working, and the 24 hours during and following exposure were used. The baseline values were subtracted from the exposure values. The calculated average exposure of corn pickers (n=17), normalized to an 8-hour work day from 5.6 hours of in-field activities, was 8.3 µg/kg-day with a standard deviation of 3.4 µg/kg-day.

Walnut Harvesters. Biomonitoring of walnut harvesters was conducted at two sites in California (Belcher, 2001b), Fresno and Porterville. The application rate was 2 pounds a.i./A, every 21 days. Harvesting occurred 14 days after the final application at the Fresno site (8 workers), and 15 days after the final application at the Porterville site (7 workers). Harvesting activities included mechanical tree shaking to dislodge nuts, hand-raking nuts from around the tree trunks and off berms, and mechanically blowing and sweeping nuts into windrows. The shakers utilized at both test sites were closed-cab units. The sweepers at the test sites were open-cab units. All workers performed harvesting activities from designated treated rows for a typical 8-hour work period that included 2 hours of breaks. Urine samples were collected for 48 hours prior to and after exposure. Twelve-hour urine samples were collected. Only the samples collected during the 24 hours before working, and the 24 hours during and following exposure were used. The baseline values were subtracted from the exposure values. The calculated average exposure of rakers (n=12) was 0.12 µg/kg-day with a standard deviation of 0.17 µg/kg-day; sweepers (n=2) received an average of 0.31 µg/kg-day; and shakers (n=2) had no measurable exposure.

Table 6 presents the results of the post-application biomonitoring studies on cotton scouts, corn pickers and walnut harvesters.

Table 6. Estimated Absorbed Daily Dosage (ADD) and Seasonal Average Daily Dosage (SADD) of Methyl Parathion for Field Workers[a]

Work Task	No. Replicates	Crop	ADD (µg/kg-d)	SADD (µg/kg-d)
Cotton Scouts	15	cotton	39.4[b]	9.4[c]
Corn Harvesters	17	corn	11.9[d]	8.33[c]
Walnut Harvest				
Rakers	12	walnuts	1.30[d]	0.12[c]
Sweepers	2	walnuts	0.31[c]	0.31[c]
Shakers	2	walnuts	-[e]	-[e]

a/ A workday of 8 hours of activity was assumed for all field workers.
b/ Represents the highest measured value as it is greater than the 95th percentile upper-bound exposure calculated from biological monitoring studies (Frank, 2009).
c/ Average exposure.
d/ The 95th percentile upper-bound exposure calculated from biological monitoring studies data calculated from biological monitoring studies data for mixer/loaders and applicators wearing work clothing, coveralls, gloves, shoes, headgear, eyewear, and respirator during application (Frank, 2009). Uses actual body weights of workers in the studies.
e/ No measurable exposure from biological monitoring data.

XII. Bystander Air Exposure

Bystander exposures to methyl parathion are principally through the inhalation route. A recent air monitoring study was conducted near application sites for the current major use of methyl parathion on walnut groves. This new data serves as the primary basis for the estimate of bystander exposure to application site air levels of methyl parathion. There have not been any recent monitoring studies of ambient air concentrations of methyl parathion in farming communities near walnut groves. However, earlier air monitoring studies showed methyl parathion in the ambient air of residential communities near rice fields treated with methyl parathion. These earlier studies will be used here as the basis of estimating acute and seasonal exposure to bystanders in farming communities.

A. Application Site Air

In June, 2002, and July, 2003, the DPR conducted studies in Tulare and San Joaquin counties around mature walnut orchards, respectively (Wofford, 2003). Methyl parathion was mixed with water in combination with other pesticides and applied at the rate of 2 lb a.i./acre through air blast application. Sampling stations at the Tulare county site were located in the perimeter of the grove (4 stations), at 10 yards from the grove (5 stations), and at 50 yards from the grove (5 stations). Low-volume air sampling pumps were used to collect air samples at a flow rate of approximately 1.5 liters per minute. Each sampler was fitted with duplicate cartridges containing XAD-2 resin adsorbent. Samples were stored on ice until delivery to the laboratory where they were kept frozen until analysis. Recoveries of spiked XAD-2 resin were good, ranging from 90% to 105%. Recoveries for XAD-2 resin media that were spiked with methyl parathion and stored in the freezer for two weeks ranged from 97% to 102%. The levels of quantitation were 70

ng/m^3 for methyl parathion, and 140 ng/m^3 for methyl paraoxon in a 12-hour collection. As all the collections were 12 hours or less, the 24-hr TWA represents an average of two collections.

Sampling stations at the San Joaquin site were on three sides of the grove: at the perimeter (8 stations), and at 10 yards (9 stations). Three additional sampling stations were located downwind at 54, 71, and 171 feet from the grove. The sampling technique was similar to that described above. No samples at the field's edge were taken during application. The prevailing wind direction in both instances was from the northwest.

At the Tulare County site, 12-hour samples were collected continuously at stations near the application site. The exceptions being the first two samples which were of 6.5 and 6 hours duration. No samples were collected at the edge of the field during the first 12-hour application interval.

At the San Joaquin County site, samples of 12-hour duration were collected continuously at the stations near the application site. In the first 12-hour period, only the stations located 10 yards from the grove and those downwind were operational. No samples were collected at the edge of the field during the first 12-hour application interval. At stations 10 yards or more from the edge of the grove, the sample collections were only 11 and 10 hours in duration, not 12 hours. At both groves the prevailing wind caused a gradient of air concentrations of methyl parathion, with the lowest values found upwind, and the highest values downwind.

At the Tulare County site, the highest value for methyl parathion at 10 yards was 1,590 ng/m^3, while the highest value at 50 yards was 750 ng/m^3.

At the San Joaquin site, the highest detected concentration of methyl parathion during the first 21-hour period at 10 yards was 4,380 ng/m^3.

Application-site air monitoring studies in California have shown concentrations ranging from 4,380 ng/m^3 at 10 yards, 1160 ng/m^3 at 17 yards, 750 ng/m^3 at 50 yards from the edge of the treated fields immediately following the application. After 2 to 6 days, these concentrations dropped to levels found in the background samples. These findings suggest that application site air concentrations decrease with increasing distance from the edge of the treated field for the first few days, and then reach a level similar to the concentrations in the background regardless of the distance from the edge of the field.

The distance from a pesticide application site to the nearest residence is variable from one site to the next. In addition, the location of people involved in outdoor activities changes during the course of the day. A single air concentration was used for the purposes of estimating acute bystander exposure to air concentrations of methyl parathion near an application site. As noted above, no "edge of field" sampling was done for the first 11-12 hours at both the Tulare and San Joaquin sites. However, the monitoring data from subsequent time periods indicated that the air concentrations of methyl parathion sampled at the edge of the field and sampled at 30 feet were indistinguishable from one another. Consequently, the highest first day's 21-hour time-

weighted-average air concentration of methyl parathion at 30 feet (4,380 ng/m^3 at the San Joaquin site) was used in estimating bystander exposures.

No methyl paraoxon was detected at any monitoring station at any time at the Tulare County site. At the San Joaquin County site, no methyl paraoxon was detected in the first 11 hours at any sampling station. The highest estimated 21-hr TWA air concentration (290 ng/m^3, assuming the first 11 hours had a concentration equivalent to ½ the LOQ) of methyl paraoxon was detected at one 10 yard monitoring station (methyl parathion concentration: 3,720 ng/m^3), but no methyl paraoxon was detected at the site with the highest methyl parathion air concentration (Table 7). As an upper bound estimate, it could be assumed that the methyl paraoxon level was equivalent to the highest measured concentration at any 10-yard monitoring site, or 290 ng/m^3.

Table 7. Methyl Parathion and Methyl Paraoxon Concentrations (ng/m^3) at 10 Yards from Walnut Grove Application Sites in Two Counties[a].

Tulare County			San Joaquin County		
Station #	Methyl Parathion (ng/m^3)[b]	Methyl Paraoxon (ng/m^3)[c]	Station #	Methyl Parathion (ng/m^3)[d]	Methyl Paraoxon (ng/m^3)[e]
1	110	ND[f]	2	3,720	290
3	270	ND	4	3,360	180
5	80	ND	6	3,030	ND
7	450	ND	8	780	ND
9	200	ND	10	1,510	ND
			13	1,680	ND
			15	1,570	ND
			17	4,380	ND

a/ Data from (Wofford, 2003)
b/ 24-hour time weighted average parathion concentration.
c/ 24-hour time weighted average paraoxon concentration.
d/ 21-hour time weighted average parathion concentration.
e/ 21-hour time weighted average paraoxon concentration; assumes non-detect concentrations measured during the first 11-hour collection are equal to ½ the level of quantitation (LOQ).
f/ ND- no quantifiable level of methyl paraoxon measured. 12-hr LOQ = 140 ng/m^3.

Exposure to application site air concentrations of methyl parathion at distances from the walnut grove such as those discussed above would be mainly for a short duration. In an ARB (1989) study, no detectable concentration of methyl parathion was found at 250 yards downwind from the application site during and after the application. Thus, families living on a farm are likely to receive acute exposures to methyl parathion that are substantially greater than those in local communities some distance away. Seasonal exposure of farm families to application site airborne methyl parathion levels would not expected to be any greater than that of the general public, as airborne concentrations reach ambient levels within a few days after the application.

The use of a single value for the air concentration of methyl parathion in an assessment of acute exposures to bystanders would seem to imply that the bystanders remain for 24 hours at the site

where the air concentration was measured. In point of fact, peoples' activity patterns tend to be somewhat more complicated, with the majority of their time spent indoors (Phillips *et al.*, 1991; Jenkins *et al.*, 1992; USEPA, 1997). Human habitations tend to be controlled environments, and the level of air contaminants inside a home compared to outside is not an exception. In response to external sources of noxious air contaminants, homes can be closed and residents can rely on air recycling and purifying devices (Hoppe and Martinac, 1998). Studies relating the differences between outdoor and indoor concentrations of air contaminants are confounded by a number of uncertainty factors: 1) whether the source is solely outdoors (Sundell and Zuber, 1996; Jo and Oh, 2001); 2) the reactivity of the air contaminants (Gold *et al.*, 1996; Jakobi and Fabian, 1997); 3) the chemical and physical properties of the contaminants (Kinney *et al.*, 2002). Two California studies indicate that indoor air concentrations of a pesticide applied solely outdoors are generally much less than the outdoor concentrations (Oshima *et al.*, 1981; Segawa *et al.*, 1991). From the descriptions of the air monitoring activities conducted in those two studies, the monitored structures were generally closed.

However, nothing on the label, or in California regulations or permit conditions requires bystanders to close up their homes during pesticide applications. Thus, both indoor and outdoor air concentrations of methyl parathion and methyl paraoxon could be the same. Given this assumption, the estimated absorbed daily doses of methyl parathion and methyl paraoxon for bystanders living adjacent to application sites are based on the highest measured air concentrations of those two chemicals.

Human exposure was calculated as an absorbed dosage. The absorbed dosage per unit of body weight varies between infants, children, adult females, and adult males because the ratio of inhalation rate to the body weight varies from one subgroup to another. Therefore, the estimate of human exposure is separated into these four subgroups. Infants of age <6 months were chosen because they usually are the highest exposure subgroup due to the highest inhalation rate to body weight ratio (Andrews and Patterson, 2000).

The degree of exposure to airborne methyl parathion depends on the inhalation rate, and the inhalation rate varies with the human activity. The total daily (24 hours) inhalation rate for each subgroup was obtained from the inhalation rate of each subgroup during various daily (24 hours) activities. The USEPA exposure factors handbook suggests an activity pattern for all age groups consisting of 11.2 hours of rest, 11.2 hours of light activity, 1.4 hours of moderate activity, and 0.2 hours of heavy activity during a 24-hour day (USEPA, 1997). The estimated absorbed dosages are presented in Table 8.

Table 8. Maximum, Acute Non-Occupational Exposure at the Application Site to Airborne Methyl Parathion and Methyl Paraoxon Based on ARB and DPR Studies.

Distance from field	**20 yards**	**17 yards**	**10 yards**	**10 yards**	**10 yards**
	Air Concentrations of Pesticide				
	Rice Field[a] (ng/m^3)	**Rice Field[a] (ng/m^3)**	**Walnut Grove[b] (ng/m^3)**	**Walnut Grove[c] (ng/m^3)**	**Walnut Grove[d] (ng/m^3)**
24-hr TWA concentration	215.4	487.0	450	4,380	290
	Absorbed Daily Dosage				
	(ng/kg-day)[e]	(ng/kg-day)[e]	(ng/kg-day)[e]	(ng/kg-day)[e]	(ng/kg-day)[f]
ADD (Infant)	128	288	266	2,593	172
ADD (Child, 3-5 yrs)	99	225	208	2,020	134
ADD (Adult female)	38	85	78	763	51
ADD (Adult male)	46	103	95	927	61

a/ Highest measured air concentration of methyl parathion from Seiber *et al*. (1987) and ARB (ARB, 1989).

b/ Highest measured air concentration of methyl parathion at 10 yards in Tulare County (Wofford *et al.*, 2003).

c/ Highest measured air concentration of methyl parathion at 10 yards in San Joaquin County (Wofford *et al*., 2003).

d/ Highest estimated air concentration of methyl paraoxon at 10 yards in San Joaquin County (Wofford *et al.*, 2003).

e/ Absorbed daily dose (ADD) of methyl parathion, calculated with current WH&S default values for breathing rates and body weights (Andrews and Patterson, 2000), using 100% inhalation retention and absorption.

f/ Absorbed daily dose (ADD) of methyl paraoxon, calculated with current WH&S default values for breathing rates and body weights (Andrews and Patterson, 2000), using 100% inhalation retention and absorption.

Shaded Area- recommended acute absorbed doses.

B. Ambient Air in Communities

People living in farming communities also have the potential to be exposed to airborne levels of methyl parathion. Consequently, ambient air levels of methyl parathion were studied in four California communities (Maxwell and Williams in Colusa County and Trowbridge and Robbins in Sutter County) near rice-growing areas which represented the highest use of methyl parathion at the time (Seiber *et al.*, 1987). That study of ambient air levels in rice-growing areas is used as a surrogate for ambient air levels in communities near walnut groves. Methyl parathion was found in higher concentrations in Colusa County locations compared to those in Sutter County. This was expected since much less methyl parathion was used in the Trowbridge and Robbins areas than what was used in the Maxwell and Williams areas. The difference between methyl parathion concentrations in the ambient air of Maxwell and Williams may also have been affected by the difference in the distance of sampling sites from actual application sites. The data suggest that residents of these areas were exposed to airborne methyl parathion and its

degradation product, methyl paraoxon, during the application period. The data also suggest that residents of other areas in California where methyl parathion is used will also be potentially exposed to airborne methyl parathion and methyl paraoxon. The acute exposure of town residents of Colusa County may be considered a surrogate worst-case scenario for communities, as, at that time, a substantial amount of methyl parathion (20-30% of the total use) was applied to the rice fields of northern California during May to mid-June.

The Seiber *et al*., 1987 study was used to estimate human exposure to methyl parathion in the ambient air in California communities, as shown in Table 9. The average 95^{th} percentile of the air concentration of methyl parathion for the 4 towns was 10.7 ng/m^3. This value was used as the hypothetical acute ambient air concentration in the community near walnut groves as they are treated during the season. An individual's exposure was calculated based on: Inhalation rates of 4.5 m^3/day, 8.3 m^3/day, 11.4 m^3/day, and 15.2 m^3/day, respectively, for an infant <6 months, a child (3-5 yrs), an adult female, and an adult male (USEPA, 1997; Andrews and Patterson, 2000). The default body weights were 7.6, 18, 65.4, and 71.8 kg, respectively, for an infant <6 months, a child (3-5 yrs), an adult female, and an adult male (USEPA, 1997; Andrews and Patterson, 2000).

Table 9. Methyl Parathion and Methyl Paraoxon in Ambient Air and Estimates of Public Exposure in Four Areas in Colusa and Sutter Counties Based on Seiber *et al.* (1987) Data

	Air Concentrations of Methyl Parathion (ng/m^3)				Methyl Paraoxon[a] (ng/m^3)	
	Sutter County		Colusa County		Colusa County	
	Trowbridge	Robbins	Maxwell	Williams	Maxwell	Williams
Mean	0.37	0.28	8.44	4.16	1.82	0.92
Standard deviation	0.44	0.26	10.63	7.02	2.25	0.57
95^{th} percentile	1.44	0.77	29.7	10.97	5.76	1.87
	Absorbed Dosage[b]				Absorbed Dosage[b]	
	(ng/kg-day)				(ng/kg-day)	
ADD (Infant)	0.85	0.48	17.6	6.50	3.41	1.11
ADD (Child, 3-5 yrs)	0.66	0.36	13.7	5.67	2.66	0.86
ADD (Adult male)	0.30	0.16	6.29	2.32	1.22	0.40
ADD (Adult female)	0.25	0.13	5.18	1.91	1.00	0.33
SADD (Infant)	0.22	0.17	5.00	2.46	1.08	0.54
SADD (Child, 3-5 yrs)	0.17	0.13	3.89	1.92	0.84	0.42
SADD (Adult male)	0.08	0.06	1.79	0.88	0.39	0.19
SADD (Adult female)	0.06	0.05	1.47	0.73	0.32	0.16

a/ No methyl paraoxon was detected in Trowbridge and Robbins towns of Sutter County. Based on: Inhalation rates of 4.5, 8.3, 11.4, and 15.2 m^3/day, respectively, for an infant, a child (3-5 yrs), an adult female, and an adult male (Table 5-23; USEPA, 1997; Andrews and Patterson, 2000). Body weights of 7.6, 18, 65.4, and 71.8 kg, respectively, for an infant, a child (3-5 yrs), an adult female, and an adult male (Table 7-3; USEPA, 1997; Andrews and Patterson, 2000).

b/ Calculation Example:

ADD = (UC x IR) / BW
SADD = (MC x IR) / BW

When: UC - 95th percentile ambient air concentration (ng/m^3)
BW - body weight (kg)
MC - Mean ambient air concentration (ng/m^3)
IR - inhalation rate (m^3/hr)

XIII. Exposure Appraisal

A. PHED

PHED data were used to estimate handler exposures to methyl parathion for pilots and mixer/loaders for ground applications, and airblast applicators. PHED, though useful, has limitations that prevent the use of distributional statistics on exposure estimates. For example, PHED incorporates exposure data from many studies, each with a different minimum detection level for the analytical method used to detect residues in the sampling media. Moreover, as the detection of dermal exposure to the body regions was not standardized, some studies observed exposure to only selected body parts. Consequently, the subsets derived from the database for

dermal exposure may have different numbers of observations for each body part, a fact that complicates interpretation of values taken from PHED. However, in the absence of chemical-specific data, PHED provided the only data available for estimating certain handler exposures to methyl parathion.

A number of uncertainties are built into PHED which can generally cause exposure estimates to be overstated. Part of this comes from the fact that approximately 70% of the inside patch data used in PHED are non-detectable values. The default assumption of using 1/2 the LOQ to estimate exposure for those non-detects may overestimate exposure. Typically, data in PHED are comprised of monitoring for only a small fraction of the workday. The data are then linearly extrapolated for the rest of the workday. The net effect may be an over-statement of exposure (Spencer *et al.*, 1979; Franklin *et al.*, 1981). The maximum amount of acres treated is always utilized in the calculations, although mechanical problems and bad weather may tend to combine to reduce the acreage treated in actual practice. Finally, it is always assumed that there is a linear relationship between the amount of pesticide handled and the amount of dermal exposure. However, as the exact nature of the relationship has not been demonstrated, this adds to the uncertainty of the estimate.

U.S. EPA also uses PHED to estimate handler exposure; however, U.S. EPA approaches PHED data somewhat differently than DPR. First, as explained in U.S. EPA's policy for use of PHED data (USEPA, 1999): "Once the data for a given exposure scenario have been selected, the data are normalized (i.e., divided by) by the amount of pesticide handled resulting in standard unit exposures (milligrams of exposure per pound of active ingredient handled). Following normalization, the data are statistically summarized. The distribution of exposure values for each body part (i.e., chest upper arm) is categorized as normal, lognormal, or "other" (i.e., neither normal nor lognormal). A central tendency value is then selected from the distribution of the exposure values for each body part. These values are the arithmetic mean for normal distributions, the geometric mean for lognormal distributions, and the median for all "other" distributions. Once selected, the central tendency values for each body part are composited into a "best fit" exposure value representing the entire body." In other words, U.S. EPA uses various central tendency estimates (often the geometric mean or median, as PHED data rarely follow a normal distribution), while DPR believes the arithmetic mean is the appropriate statistic regardless of the sample distribution (Powell, 2003). Second, for acute exposure estimates DPR uses a 95^{th} percentile upper bound estimate, while US EPA uses a central tendency estimate for all exposure durations. Third, DPR calculates upper 90% confidence limits for both upper bound and mean exposures, while U.S. EPA does not. The differences between acute exposure estimates calculated according to DPR and U.S. EPA policies are summarized in Table 10 for an example scenario, airblast applicator.

Table 10. Comparison of Ground Mixer/Loader Exposure to Methyl Parathion Estimated from Surrogate Data (PHED) by DPR and US EPA According to Their Respective Policies.

Exposure Estimate	Exposure Rate (µg AI/lb handled) [a]	Acute ADD (µg/kg-day) [b]
From PHED, according to DPR policy	406 [c]	265 [c]
From PHED, according to US EPA policy [d]	102	58

a/ Total exposure rate, dermal plus inhalation.

b/ Acute Absorbed Daily Dosage (ADD) estimates assumed a maximum application rate of 1 lb a.i./acre, maximum rate on field-grown ornamentals, and an 8-hour workday. Amount treated was assumed to be 100 acres treated/day(Haskell, 1998), except for US Environmental Protection Agency (US EPA) estimate, which assumed 80 acres treated/day (USEPA, 2001). Dermal absorption assumed to be 50%, inhalation absorption was assumed to be 100%, and body weight was assumed to be 77 kg (DPR) or 70 kg(USEPA, 1997).

c/ Upper-bound rate defined by the Department of Pesticide Regulation (DPR) policy described in Exposure Assessment section. Exposure rate and acute ADD are from Table 2.

d/ Average rate used for U.S. EPA exposure estimates calculated from values obtained from U.S. EPA Policies (USEPA, 1999). Data taken from **M/L, Open System, Liquids (With Gloves)** in PHED.

Finally, it should be noted that the use of surrogate pesticide data (like PHED) and default assumptions necessarily incorporate additional uncertainties in the exposure estimate. Such an inference can be drawn from comparing the estimated exposures of mixer/loaders (Table 2). In this instance, chemical specific data from a biomonitoring study indicated that mixer/loaders involved in aerial applications (that handle 5 times the amount of methyl parathion as mixer/loaders engaged in ground applications) were estimated to have exposures that were 1/30 of the mixer/loaders for ground applications. Appropriate chemical specific exposure data would be preferred.

B. Bystander Exposures

The assessment of bystander exposure to a potential toxic air contaminant rests on many assumptions. None of the monitoring data were collected at actual home sites adjacent to treated walnut groves (Wofford, 2003). Consequently, the distance that such a residence would be from a treated grove is a matter of uncertainty. In this case, WH&S has assumed that the distance is minimal, as the air concentrations of methyl parathion and methyl paraoxon that were used in the calculations were indistinguishable from those at the edge of the grove. Likewise, the locations of small children and adults during the periods of time they would have spent outdoors are also matters of uncertainty. In this document, all individuals exposed to outdoor concentrations or methyl parathion were assumed to breathe the maximum concentrations of methyl parathion and methyl paraoxon for the entire time. Yet, field-monitoring data indicate there can be a steep drop-off in ambient air concentrations of methyl parathion as the distance from the treated area increases. For example, at 75 yards in the first DPR monitoring study there was no discernible air concentration of methyl parathion. It should also be noted that a home has dimensions, and not all portions of a house will be located precisely where the highest levels of methyl parathion

and methyl paraoxon were measured. The quantitative effect of building dimensions on the calculated exposures of individuals to indoor levels of methyl parathion and methyl paraoxon cannot be enumerated, but it adds to the uncertainty of the estimates.

As noted earlier, there can be a substantial difference between indoor and outdoor air concentrations of a pesticide (Oshima *et al.,* 1981; Segawa *et al.,* 1991). If a structure were to remain closed during the first 24 hours after application, it is likely that the residents would have substantially less exposure than if the structure were open. This assertion is based on the following: Malathion could be used as a surrogate pesticide air contaminant because: 1) it has a vapor pressure (4×10^{-5} mmHg at 30 °C) similar to methyl parathion (1.7×10^{-5} mmHg at 25 °C), 2) the malathion formulation has a noxious odor (due to inerts, and thiols, sulfides and disulfides produced in the manufacturing process) like the methyl parathion formulation so it would be reasonable to assume that windows and doors would be closed as much as possible, 3) the monitored surrogate homes and structures were located in the areas sprayed directly with malathion; 4) extensive measurements of outdoor and indoor air concentrations of malathion vapor were conducted. The fact that the homes and other structures monitored for malathion were located in an urban area, rather than on a farm (Oshima *et al.,* 1981; Segawa *et al.,* 1991), would contribute a degree of uncertainty. However, the fact that more that 80 structures were monitored would tend to take potential architectural differences between urban and farm structures into consideration.

Finally, the reported methyl paraoxon values are probably overestimates because artificial oxidation of methyl parathion to methyl paraoxon occurs with the sampling technique employed (Segawa *et al.,* 1991). However, the amount of oxidation that occurs during the sampling process cannot be determined with accuracy, so this adds to the uncertainty of the estimated ambient air concentrations of methyl paraoxon.

C. Dermal Absorption

The process of determining an average dermal absorption value to be used to estimate absorbed dose in some of the scenarios creates uncertainty. There were no *in vivo,* human dermal absorption studies for methyl parathion. An *in vitro* dermal absorption study with human skin indicated that human dermal absorption ranged from 1.4 to 9% (Sartorelli *et al.,* 1997). However, the study had a host of technical problems, and *in vitro* studies are not currently used by DPR for establishing the rate of dermal absorption. There was an *in vivo* rat dermal absorption study, indicating 96% dermal absorption of methyl parathion (Sved, 2001). This study was used as the basis for the established, U.S. EPA dermal absorption rate (USEPA, 2006). However, additional data suggests that this absorption rate may not be accurate for humans.

The dermal absorption of ethyl parathion, chemically very similar to methyl parathion, was 95% in rats (Shah *et al.,* 1987). Yet, *in vivo* dermal absorption on the forearm of humans was shown to be approximately 10% (Feldmann and Maibach, 1974). One would expect a similar relationship between the percentage dermal absorption in rats and humans for methyl parathion. This value (10%), though, could not be used as the basis for human dermal absorption of methyl parathion because acetone was used in the study as the application vehicle. Acetone disrupts the

integrity of the skin surface, and alters the rate of dermal absorption (Zendzian, 1994). Also, other data indicated that *in vivo* human dermal absorption of ethyl parathion, though less than 95%, is variable (ranging from 4% to 64%) depending on the portion of the body to which it was applied (Maibach *et al.*, 1971; Feldmann and Maibach, 1974; Wester and Maibach, 1985). Again, because the application vehicle was acetone, these dermal absorption rates are likely overestimates.

Another approach to estimating the rate of human dermal absorption of methyl parathion was investigated. The data used in the paper came from several studies of the human dermal absorption of 47 radio-labeled compounds, dissolved in acetone, applied to the ventral forearm (Durkin *et al.*, 1995). Durkin *et al.* (Durkin *et al.*, 1995) had found that there was a correlation between molecular weight and the human dermal absorption rate. This correlation, though, was good only for compounds with log of octanol-water partition coefficient (K_{ow}) > 1.85. Methyl parathion has a molecular weight of 263.2 and log K_{ow} = 2.8. Using Durkin's formula (log Absorption Rate = -0.005 MW + 2.1), the dermal absorption of methyl parathion would be ~6.1%. This value is in the range of the estimated dermal absorption of human skin from the *in vitro* studies (Sartorelli *et al.*, 1997).

The Worker Health and Safety policy, however, is to assume a default of 50% dermal absorption if there are no satisfactory *in vivo* dermal absorption studies (Donahue, 1996). The question then arose as to whether such an assumed dermal absorption rate (50%) could be considered sufficiently health protective given that U.S. EPA used a dermal absorption value of 100%. In order to gain insight into this question, the absorbed dose of methyl parathion for mixer/loaders engaged in aerial applications was examined. Biomonitoring data indicated that the absorbed dose for those mixer/loaders was 6.38 µg/kg-day (Rotondaro, 2002). Assuming the same application rate, using PHED to estimate dermal exposure and a 50% dermal absorption rate, the estimated absorbed dose for those same mixer/loaders was twenty-fold higher, 131 µg/kg-day. This comparison suggests that an assumed dermal absorption rate of 50% is health protective.

Finally, the only formulation containing methyl parathion registered for use in California is a microencapsulated formulation. The dermal toxicity (LD_{50}) of the microencapsulated formulation of methyl parathion in rabbits and rats is nearly an order of magnitude less than the reagent grade material on the basis of per milligram of active ingredient (Tsuji, 1991). As the percent dermal absorption used in this document is based on the absorption rate (50%) of the unpackaged active ingredient, the use of that rate in estimating absorbed dose adds to the health protectiveness.

D. Biological Monitoring Data

The biological monitoring studies only provided data on how much of a metabolite, 4-paranitrophenol, appeared in the urine of workers (Willard, 2000b; Willard, 2000a; Belcher, 2001a; Belcher, 2001b; Willard, 2001; Rotondaro, 2002). In order to convert this measured parameter into an estimate of absorbed dose, there must be a human pharmacokinetic study which demonstrates how much of an ingested dose of methyl parathion is excreted as 4-paranitrophenol within a given period of time. The total amount of paranitrophenol excreted in

the human pharmacokinetic study averaged 27% in a 24-hour period, with no detectable metabolite in the urine after 24 hours (Morgan *et al.*, 1977). Yet, despite isolation in hotel rooms, nearly all of the workers in the biomonitoring studies had paranitrophenol in their urine during the 48 hours before the studies began. This suggests that there were other sources for the paranitrophenol in the urine than exposure to methyl parathion. Indeed, several other common chemicals produce this same metabolite that was used as an indicator of exposure to methyl parathion. These chemicals include acetaminophen, shoe polish, furniture polish, floor polish, leather dressings, paint solvents, gun bluing, metal polishes, scented soaps, spray paints, anything with almond essence, and perfumes.

Although urine was collected for 48 hours prior to workers being actively exposed to methyl parathion, only the amount of paranitrophenol measured in the urine during the 24 hours immediately before the exposure activities was used to establish the baseline. The baseline paranitrophenol is the amount excreted in the urine that is unrelated to methyl parathion exposure. The first 24-hour urine collections in the hotel rooms (prior to exposure activities) may have contained amounts of paranitrophenol related to previous activities involving exposure to methyl parathion. Although baseline levels of the metabolite, paranitrophenol, were subtracted from the "exposure sample", the fact that there were detectable levels in the urine during the 24 hours preceding the studies' activities increases the uncertainty in those estimated exposures.

E. Pharmacokinetics

Absorbed dosage is expressed as a single static value both in worker exposure and animal toxicology studies. The rate, not just the percentage, of dermal absorption tends to be much lower than that of oral absorption in animals used for toxicology testing. Adverse effects occur when plasma levels in the target organ exceed a critical level (Eaton and Klaassen, 1996). However, dermal absorption occurs over the entire work day. Thus, the amount absorbed dermally will not produce the same plasma levels as that same dose would if given by oral gavage or diet. As systemic toxicity is highly dependent on plasma levels, treating an 8-hour dermal acquisition as a bolus likely errs on the side of overstating toxic exposure. An example may be seen in Table 11 from Auton *et al* (Auton *et al.*, 1993)1993). Even though the dermally absorbed doses were greater than the absorbed oral dose, the peak plasma levels from dermal absorption were lower. This difference becomes more pronounced when an oral toxicity study is used to characterize the risks of dermal exposure.

Table 11. Peak Plasma Levels in Humans After Oral and Dermal Exposure to Fluazifop-Butyl, Normalized for Total Absorbed Dose[a].

Applied Dose (mg)	Route of Exposure	Absorption (% of Applied)[b]	Peak Plasma Level (g/L/mg)[c]
6.1	oral	100.0	100.0 (3 hr)
200.0	dermal	1.5	73.3 (22 hr)
20.0	dermal	3.4	32.4 (22 hr)

a/ Adapted from Auton *et al*. (1993).

b/ *In vivo* absorption as measured by Auton *et al*. (1993).

c/ Normalized for total absorbed dose; in parentheses are the intervals between the time of dosing and the time at which the peak plasma level occurred.

F. Longer Term Exposures

For reentry workers, harvesting walnuts does not require an extended period of time. Consequently, no AADDs were developed for the walnut harvesters. Cotton scouts were assumed to work in methyl parathion-treated fields for a total of 21 days/year. That amount of time constitutes about 6% of the year, and cannot reasonably be considered a chronic exposure.

G. Area Treated

The generic data in PHED are used to estimate handler exposures when there are no chemical-specific data available. These data, expressed as the amount of pesticide handled, are a product of (1) the amount of pesticide used on each acre and (2) the number of acres treated. The amount of pesticide assumed to be used on each acre in this exposure assessment is the maximum, label approved application rate. The estimates of the number of acres treated (Haskell, 1998), both upper-bound (for acute exposure estimates) and average (for repetitive exposure estimates), were based on information developed from that individual's contacts within the farming community.

For estimates of acute exposures, the upper-bound exposure of handlers performing a given work task was adjusted for the maximum application rate for methyl parathion, which was assumed to be used on the maximum acreage that can be treated in a given day. While an upper-bound exposure is considered a low probability event, we believe it does occur.

For estimates of repetitive exposure, an average or typical exposure is desired. However, data regarding average application rates were not available for this chemical. Consequently, it was assumed that handlers would use methyl parathion at the maximum application rate (as listed on the label) on an average number of acres. Handlers using a lower application rate would likely experience reduced exposure to methyl parathion.

XIV. References

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Appendix I:

Biomonitoring Data and Calculations of Absorbed Daily Dose

Table I-1. Aerial Mixer/Loaders: Biomonitoring Data from Arizona and Mississippi.

Site[a]	p-NP[b] 24hr (µg/L)	Volume[c] (L)	p-NP (µg)	MWMP/MWnP[d] 1.89/.27	MP[e] (µg)	weight (kg)	MPexp[f] (µg/kg-d)	Corr. MP[g] (µg/kg-d)	Amount Handled[h] (lb)	Pot. Abs. MP dose[i] (µg/kg-d)
pre-MS1	1.91	2.878	5.49698	7	38.47886	78.1	0.492687		350	
MS1	13.90	1.729	24.0331	7	168.2317	78.1	2.154055	1.661368	350	4.984104
pre-MS2	0.84	4.016	3.37344	7	23.61408	98.4	0.23998		350	
MS2	7.81	1.666	13.01146	7	91.08022	98.4	0.925612	0.685632	350	2.056895
pre-MS3	0.15	4.188	0.6282	7	4.3974	66.4	0.066226		350	
MS3	1.62	4.616	7.47792	7	52.34544	66.4	0.788335	0.722109	350	2.166327
pre-MS4	1.20	3.103	3.7236	7	26.0652	84.3	0.309196		350	
MS4	3.29	3.115	10.24835	7	71.73845	84.3	0.85099	0.541794	350	1.625383
pre-MS5	1.65	2.206	3.6399	7	25.4793	94.5	0.269622		350	
MS5	11.20	1.694	18.9728	7	132.8096	94.5	1.405393	1.13577	350	3.407311
pre-AZ-1-1	2.26	2.350	5.311	7	37.177	129.3	0.287525		350	
AZ-1-1	15.10	3.556	53.6956	7	375.8692	129.3	2.906954	2.619429	350	7.858288
pre-AZ-1-2	3.33	2.001	6.66333	7	46.64331	74.1	0.629464		350	
AZ-1-2	11.70	2.392	27.9864	7	195.9048	74.1	2.643789	2.014325	350	6.042975
pre-AZ-1-3	2.52	2.690	6.7788	7	47.4516	89.8	0.528414		350	
AZ-1-3	27.30	1.734	47.3382	7	331.3674	89.8	3.69006	3.161646	350	9.484938
pre-AZ-1-4	1.07	3.310	3.5417	7	24.7919	58.1	0.426711		350	
AZ-1-4	19.50	1.009	19.6755	7	137.7285	58.1	2.370542	1.943831	350	5.831494
pre-AZ-1-5	1.27	2.896	3.67792	7	25.74544	66.1	0.389492		350	
AZ-1-5	26.40	1.456	38.4384	7	269.0688	66.1	4.070632	3.68114	350	11.04342
pre-AZ-2-1	3.48	2.823	9.82404	7	68.76828	94.5	0.727707		350	
AZ-2-1	4.30	3.411	14.6673	7	102.6711	94.5	1.086467	0.35876	350	1.07628
pre-AZ-2-2	1.71	2.770	4.7367	7	33.1569	70.7	0.46898		350	
AZ-2-2	3.75	3.279	12.29625	7	86.07375	70.7	1.21745	0.74847	350	2.245411
pre-AZ-2-3	1.01	4.704	4.75104	7	33.25728	75.2	0.442251		350	
AZ-2-3	3.66	4.213	15.41958	7	107.9371	75.2	1.435333	0.993082	350	2.979247
pre-AZ-2-4	2.38	3.019	7.18522	7	50.29654	83	0.605982		350	
AZ-2-4	6.60	1.909	12.5994	7	88.1958	83	1.0626	0.456618	350	1.369853
pre-AZ-2-5	2.10	2.817	5.9157	7	41.4099	63.9	0.648042		350	
AZ-2-5	7.06	1.388	9.79928	7	68.59496	63.9	1.073474	0.425431	350	1.276294
pre-AZ-2-6	2.55	2.818	7.1859	7	50.3013	91.4	0.550342		350	
AZ-2-6	5.45	1.521	8.28945	7	58.02615	91.4	0.634859	0.084517	350	0.253551

a/ Five or six workers for each of 2 sites in Arizona (AZ) and five workers for one site in Mississippi (MS) are listed. For each worker, the 24-hour pre-exposure sample is listed first, followed by the 24-hour exposure sample for the same worker.

b/ p-NP - measured concentration of paranitrophenol in the pooled, collected urine for that 24-hour period as given in the reports.

c/ The total volume of urine collected in that 24-hour period as listed in the reports.

d/ In order to convert the amount of paranitrophenol collected during the 24-hour period to the amount of methyl parathion, the total p-NP is multiplied by the ratio of the molecular weight of methyl parathion to the molecular weight of the metabolite, paranitrophenol, and divided by the fraction of paranitrophenol (0.27) which comes out in the urine of humans within 24 hours of exposure to methyl parathion.

e/ Estimated equivalent amount of methyl parathion collected in the 24-hour period.

f/ Methyl parathion exposure (estimated absorbed dose per kg body weight).

g/ Corrected methyl parathion for each worker, the pre-exposure MP is subtracted from the post-exposure MP to yield the corrected absorbed dose.

h/ Amount of methyl parathion handled expressed as pounds of formulation.

i/ Pot. Abs. MP dose - Worker Health and Safety assumed that up to 1100 acres could be treated via aerial application. Assuming a linear relationship between the amount handled and exposure, the amount handled was multiplied by 3 (cycles) to yield the potential absorbed dose for mixer/loaders preparing enough formulation for treating 1100 acres.

Table I-2: Aerial Mixer/Loaders: Biomonitoring Data from Louisiana and Arkansas.

Site[a]	p-NP[b] 24hr (µg/L)	Volume[c] (L)	p-NP (µg)	MWMP/ MWnP[d] 1.89/.27	MP[e] (µg)	Weight (kg)	MPexp[f] (µg/kg-d)	Corr. MP[g] (µg./kg-d)	Amount Handled[h] (lb Form)	3 cycles[i] (µg/kg-d)
pre-AR-3	5.33	1.502	8.00566	7	56.03962	77.1	0.726843		360	
AR-3	55.80	1.510	84.258	7	589.806	77.1	7.649883	6.92304	360	20.76912
pre-AR-4	3.43	2.756	9.45308	7	66.17156	68.0	0.973111		360	
AR-4	16.70	1.863	31.1121	7	217.7847	68.0	3.202716	2.229605	360	6.688815
pre-AR-7	1.31	2.423	3.17413	7	22.21891	88.5	0.251061		360	
AR-7	48.10	2.174	104.5694	7	731.9858	88.5	8.271026	8.019965	360	24.05989
pre-AR-8	2.97	1.353	4.01841	7	28.12887	102.1	0.275503		360	
AR-8	75.70	1.696	128.3872	7	898.7104	102.1	8.802257	8.526753	360	25.58026
pre-AR-10	3.25	1.611	5.23575	7	36.65025	90.7	0.404082		360	
AR-10	38.70	1.554	60.1398	7	420.9786	90.7	4.64144	4.237358	360	12.71207
pre-LA-12	2.51	2.508	6.29508	7	44.06556	102.1	0.431592		345	
LA-12	11.00	2.989	32.879	7	230.153	102.1	2.254192	1.8226	345	5.467799
pre-LA-14	5.91	1.565	9.24915	7	64.74405	79.4	0.815416		345	
LA-14	16.90	0.988	16.6972	7	116.8804	79.4	1.472045	0.656629	345	1.969887
pre-LA-16	9.03	2.375	21.44625	7	150.1238	107.0	1.403026		345	
LA-16	11.30	2.214	25.0182	7	175.1274	107.0	1.636705	0.233679	345	0.701037
pre-LA-19	5.78	1.579	9.12662	7	63.88634	81.2	0.786778		345	
LA-19	28.80	0.707	20.3616	7	142.5312	81.2	1.75531	0.968533	345	2.905598
pre-LA-20	5.58	1.440	8.0352	7	56.2464	60.8	0.925105		345	
LA-20	11.80	0.975	11.505	7	80.535	60.8	1.324589	0.399484	345	1.198451

a/ Five workers for each site in Arkansas (AR) and Louisiana (LA) are listed. For each worker, the 24-hour pre-exposure sample is listed first, followed by the 24-hour exposure sample for the same worker.

b/ p-NP - measured concentration of paranitrophenol in the pooled, collected urine for that 24 hour period as given in the reports.

c/ The total volume of urine collected in that 24 hour period as listed in the reports.

d/ In order to convert the amount of paranitrophenol collected during the 24-hour period to the amount of methyl parathion, the total p-NP is multiplied by the ratio of the molecular weight of methyl parathion to the molecular weight of the metabolite, paranitrophenol, and divided by the fraction of paranitrophenol (0.27) which comes out in the urine of humans within 24 hours of exposure to methyl parathion.

e/ Estimated equivalent amount of methyl parathion collected in the 24-hour period.

f/ Methyl parathion exposure (estimated absorbed dose per kg body weight).

g/ Corrected methyl parathion for each worker, the pre-exposure MP is subtracted from the post-exposure MP to yield the corrected absorbed dose.

h/ Amount of methyl parathion handled expressed as pounds of formulation.

i/ Pot. Abs. MP dose - Worker Health and Safety assumed that up to 1100 acres could be treated via aerial application. Assuming a linear relationship between the amount handled and exposure, the amount handled was multiplied by 3 (cycles) to yield the potential absorbed dose for mixer/loaders preparing enough formulation for treating 1100 acres.

Table I-3. Walnut Harvesters: Biomonitoring Data from California

Site[a]	p-NP[b] 24-Hour Period (µg/L)	Volume[c] Collected (L)	p-NP (µg)	Ratio of Molecular Weights[d] 1.89/0.27	Methyl Parathion[e] (µg)	Body Weight (kg)	Methyl Parathion Exposure[f] (µg/kg-d)	Corrected Methyl Parathion Exposure[g] (µg./kg-d)
pre-CA-1	1.49	3.296	4.91104	7	34.37728	86	0.399736	
CA-1-S[h]	1.66	2.118	3.51588	7	24.61116	86	0.286176	0
pre-CA-2	1.67	3.043	5.08181	7	35.57267	80	0.444658	
CA-2-r/s[i]	1.31	3.628	4.75268	7	33.26876	80	0.41586	0
pre-CA-3	1.26	2.209	2.78334	7	19.48338	77	0.253031	
CA-3	2.27	2.550	5.7885	7	40.5195	77	0.526227	0.273196
pre-CA-4	2.59	2.180	5.6462	7	39.5234	95	0.416036	
CA-4	4.92	1.492	7.34064	7	51.38448	95	0.540889	0.124853
pre-CA-5	1.40	4.029	5.6406	7	39.4842	109	0.36224	
CA-5	2.19	2.830	6.1977	7	43.3839	109	0.398017	0.035777
pre-CA-6	4.93	0.697	3.43621	7	24.05347	73	0.3295	
CA-6	6.37	1.326	8.44662	7	59.12634	73	0.80995	0.48045
Pre-CA-7	2.46	1.761	4.33206	7	30.32442	91	0.333235	
CA-7	2.61	2.753	7.18533	7	50.29731	91	0.552718	0.219482
pre-CA-8	2.62	2.298	6.02076	7	42.14532	86	0.490062	
CA-8	2.45	2.328	5.7036	7	39.9252	86	0.464247	0
pre-CA-9	2.27	2.593	5.88611	7	41.20277	68	0.605923	
CA-9	3.92	1.807	7.08344	7	49.58408	68	0.729178	0.123255
pre-CA-10	2.45	2.091	5.12295	7	35.86065	86	0.416984	
CA-10	1.91	2.799	5.34609	7	37.42263	86	0.435147	0.018163
pre-CA-11	4.52	1.055	4.7686	7	33.3802	73	0.457263	
CA-11	1.85	0.952	1.7612	7	12.3284	73	0.168882	0
pre-CA-12	4.71	2.170	10.2207	7	71.5449	86	0.831917	
CA-12	3.38	2.027	6.85126	7	47.95882	86	0.557661	0
pre-CA-13	2.86	2.485	7.1071	7	49.7497	79	0.629743	
CA-13	0.88	3.294	2.88225	7	20.17575	79	0.255389	0
pre-CA-14	6.55	2.939	19.25045	7	134.7532	86	1.566897	
CA-14-S	5.46	2.729	14.90034	7	104.3024	86	1.212818	0
pre-CA-15	2.51	2.536	6.36536	7	44.55752	102	0.436838	
CA-15-r/s[i]	7.68	1.710	13.1328	7	91.9296	102	0.901271	0.464432

a/ Fifteen workers from two sites in California (CA) are listed. For each worker, the 24-hour pre-exposure sample is listed first, followed by the 24-hour exposure sample for the same worker.

b/ p-NP - measured concentration of paranitrophenol in the pooled, collected urine for that 24-hour period as given in the study reports.

c/ The total volume of urine collected in that 24-hour period as listed in the study reports.

d/ In order to convert the amount of paranitrophenol collected during the 24-hour period to the amount of methyl parathion, the total p-NP is multiplied by the ratio of the molecular weight of methyl parathion to the molecular weight of the metabolite, paranitrophenol, and divided by the fraction of paranitrophenol (0.27) which comes out in the urine of humans within 24 hours of exposure to methyl parathion.

e/ Estimated equivalent amount of methyl parathion collected in the 24-hour period.

f/ Methyl parathion exposure (estimated absorbed dose per kg body weight).

g/ Corrected methyl parathion for each worker, the pre-exposure MP is subtracted from the post-exposure MP to yield the corrected absorbed dose.

h/ S - indicates the shakers

i/ r/s - indicates the sweepers

Table I-4. Corn Harvesters: Biomonitoring Data from Florida

Site[a]	p-NP[b] in 24-Hour Period (µg/L)	Volume[c] Collected (L)	Amount of para-Nitrophenol (µg)	Ratio of Molecular Weights[d] 1.89/0.27	Methyl Parathion[e] (µg)	Body Weight (kg)	Methyl Parathion Exposure[f] (µg/kg-d)	Corrected Methyl Parathion Exposure[g] (µg./kg-d)
pre-FL-1	6.99	1.481	10.35219	7	72.46533	61	1.187956	
FL-1	229	0.203	46.487	7	325.409	61	5.334574	4.146618
pre-FL-2	1.88	1.455	2.7354	7	19.1478	64	0.299184	
FL-2	25.1	1.792	44.9792	7	314.8544	64	4.9196	4.620416
pre-FL-3	1.87	1	1.87	7	13.09	63	0.207778	
FL-3	49.6	0.734	36.4064	7	254.8448	63	4.045156	3.837378
pre-FL-4	8.43	1.378	11.61654	7	81.31578	61	1.333046	
FL-4	65.9	0.913	60.1667	7	421.1669	61	6.904375	5.57133
pre-FL-5	9.08	1.11	10.0788	7	70.5516	59	1.19579	
FL-5	95.2	0.752	71.5904	7	501.1328	59	8.493776	7.297986
pre-FL-6	2.37	1.155	2.73735	7	19.16145	68	0.281786	
FL-6	37.3	1.159	43.2307	7	302.6149	68	4.450219	4.168433
pre-FL-8	2.23	0.788	1.75724	7	12.30068	68	0.180892	
Fl-8	77.7	0.665	51.6705	7	361.6935	68	5.319022	5.13813
pre-FL-9	3.74	1.145	4.2823	7	29.9761	68	0.440825	
FL-9	63.6	0.872	55.4592	7	388.2144	68	5.709035	5.26821
pre-FL-10	13.7	0.785	10.7545	7	75.2815	50	1.50563	
FL-10	65.6	0.802	52.6112	7	368.2784	50	7.365568	5.859938
pre-FL-11	2.99	1.385	4.14115	7	28.98805	61	0.475214	
FL-11	72.4	0.935	67.694	7	473.858	61	7.768164	7.29295
pre-FL-12	1.98	1.708	3.38184	7	23.67288	68	0.348131	
FL-12	99.5	1.011	100.5945	7	704.1615	68	10.35532	10.00719
pre-FL-13	0.922	2.375	2.18975	7	15.32825	59	0.259801	
FL-13	96.2	1.069	102.8378	7	719.8646	59	12.20109	11.94129
pre-FL-14	3.46	1.112	3.84752	7	26.93264	59	0.456485	
FL-14	48.6	0.789	38.3454	7	268.4178	59	4.549454	4.092969
pre-FL-15	2.17	0.716	1.55372	7	10.87604	63	0.172636	
FL-15	137	0.26	35.62	7	249.34	63	3.957778	3.785142
pre-FL-16	1.72	1.313	2.25836	7	15.80852	59	0.267941	
FL-16	36.7	1.567	57.5089	7	402.5623	59	6.82309	6.555149
pre-FL-17	2.81	0.985	2.76785	7	19.37495	71	0.272887	
FL-17	75.5	0.529	39.9395	7	279.5765	71	3.937697	3.664811

a/ Seventeen workers from Florida (FL) are listed. For each worker, the 24-hour pre-exposure sample is listed first, followed by the 24-hour exposure sample for the same worker.

b/ p-NP - measured concentration of paranitrophenol in the pooled, collected urine for that 24-hour period as given in the study reports.

c/ The total volume of urine collected in that 24-hour period as listed in the study reports.

d/ In order to convert the amount of paranitrophenol collected during the 24-hour period to the amount of methyl parathion, the total p-NP is multiplied by the ratio of the molecular weight of methyl parathion to the molecular weight of the metabolite, paranitrophenol, and divided by the fraction of paranitrophenol (0.27) which comes out in the urine of humans within 24 hours of exposure to methyl parathion.

e/ Estimated equivalent amount of methyl parathion collected in the 24-hour period.

f/ Methyl parathion exposure (estimated absorbed dose per kg body weight).

g/ Corrected methyl parathion for each worker, the pre-exposure MP is subtracted from the post-exposure MP to yield the corrected absorbed dose.

Table I-5. Cotton Scouts: Biomonitoring Data from California, Louisiana, and Texas

Site[a]	p-NP[b] in 24-Hour Period (µg/L)	Volume[c] Collected (L)	Amount of para-Nitrophenol (µg)	Ratio of Molecular Weights[d] 1.89/0.27	Methyl Parathion[e] (µg)	Body Weight (kg)	Methyl Parathion Exposure[f] (µg/kg-d)	Corrected Methyl Parathion Exposure[g] (µg./kg-d)
pre-CA-1	6.02	2.134	12.84668	7	89.92676	66	1.362527	
CA-1	3.75	3.067	11.50125	7	80.50875	66	1.21983	0
pre-CA-3	1.95	1.258	2.4531	7	17.1717	77	0.223009	
CA-3	44.00	1.391	61.204	7	428.428	77	5.564	5.340991
pre-CA-4	4.29	1.459	6.25911	7	43.81377	73	0.600189	
CA-4	15.40	1.386	21.3444	7	149.4108	73	2.046723	1.446535
pre-CA-7	2.84	3.584	10.17856	7	71.24992	53	1.344338	
CA-7	2.20	4.361	9.5942	7	67.1594	53	1.267158	0
pre-CA-10	4.03	1.478	5.95634	7	41.69438	70	0.595634	
CA-10	26.40	1.682	44.4048	7	310.8336	70	4.44048	3.844846
pre-LA-1	6.29	1.475	9.27775	7	64.94425	129	0.503444	
LA-1	10.70	1.908	20.4156	7	142.9092	129	1.107823	0.604379
pre-LA-2	3.13	0.815	2.55095	7	17.85665	84	0.212579	
LA-2	45.90	0.923	42.3657	7	296.5599	84	3.530475	3.317896
pre-LA-3	1.22	1.665	2.0313	7	14.2191	59	0.241002	
LA-3	8.64	2.602	22.48128	7	157.369	59	2.667271	2.426269
pre-LA-4	3.14	1.939	6.08846	7	42.61922	75	0.568256	
LA-4	39.10	0.929	36.3239	7	254.2673	75	3.390231	2.821974
pre-LA-5	6.10	1.167	7.1187	7	49.8309	118	0.422296	
LA-5	16.40	1.382	22.6648	7	158.6536	118	1.344522	0.922226
pre-TX-1	2.33	1.181	2.75173	7	19.26211	93	0.207119	
TX-1	4.43	2.533	11.22119	7	78.54833	93	0.844606	0.637486
pre-TX-2	3.40	1.533	5.2122	7	36.4854	92	0.39658	
TX-2	2.30	3.228	7.4244	7	51.9708	92	0.5649	0.16832
pre-TX-3	3.72	0.529	1.96788	7	13.77516	120	0.114793	
TX-3	10.40	1.381	14.3624	7	100.5368	120	0.837807	0.723014
pre-TX-4	1.70	1.269	2.1573	7	15.1011	79	0.191153	
TX-4	3.11	1.860	5.7846	7	40.4922	79	0.512559	0.321406
pre-TX-5	2.33	1.125	2.62125	7	18.34875	103	0.178143	
TX-5	5.61	2.233	12.52713	7	87.68991	103	0.851358	0.673215

a/ Fifteen workers, five from California (CA), five from Louisiana (LA) and five from Texas (TX) are listed. For each worker, the 24-hour pre-exposure sample is listed first, followed by the 24-hour exposure sample for the same worker.

b/ p-NP - measured concentration of paranitrophenol in the pooled, collected urine for that 24-hour period as given in the study reports.

c/ The total volume of urine collected in that 24-hour period as listed in the study reports.

d/ In order to convert the amount of paranitrophenol collected during the 24-hour period to the amount of methyl parathion, the total p-NP is multiplied by the ratio of the molecular weight of methyl parathion to the molecular weight of the metabolite, paranitrophenol, and divided by the fraction of paranitrophenol (0.27) which comes out in the urine of humans within 24 hours of exposure to methyl parathion.

e/ Estimated equivalent amount of methyl parathion collected in the 24-hour period.

f/ Methyl parathion exposure (estimated absorbed dose per kg body weight).

g/ Corrected methyl parathion for each worker, the pre-exposure MP is subtracted from the post-exposure MP to yield the corrected absorbed dose.

Table I-6. Groundboom Applicators: Biomonitoring Data from Florida, Washington, and Wisconsin

Site[a]	p-NP[b] in 24-Hour Period (µg/L)	Volume[c] Collected (L)	Amount of para-Nitrophenol (µg)	Ratio of Molecular Weights[d] 1.89/0.27	Methyl Parathion[e] (µg)	Body Weight (kg)	Methyl Parathion Exposure[f] (µg/kg-d)	Corrected Methyl Parathion Exposure[g] (µg./kg-d)
pre-FL-1	3.12	4.92	15.3504	7	107.4528	125	0.859622	
FL-1	81.1	3.423	277.6053	7	1943.237	125	15.5459	14.68627
pre-FL-2	9.15	2.711	24.80565	7	173.6396	127	1.367241	
FL-2	25.8	2.166	55.8828	7	391.1796	127	3.080154	1.712914
pre-FL-3	7.05	3.072	21.6576	7	151.6032	86	1.762828	
FL-3	14.1	3.203	45.1623	7	316.1361	86	3.676001	1.913173
pre-FL-4	3.06	4.122	12.61332	7	88.29324	86	1.026666	
FL-4	50.1	1.446	72.4446	7	507.1122	86	5.896653	4.869988
pre-FL-5	2.87	1.779	5.10573	7	35.74011	86	0.415583	
FL-5	29.8	1.199	35.7302	7	250.1114	86	2.908272	2.492689
pre-WA-6	0.92	7.165	6.5918	7	46.1426	68	0.678568	
WA-6	43.6	2.457	107.1252	7	749.8764	68	11.02759	10.34903
pre-WA-7	5.38	1.355	7.2899	7	51.0293	80	0.637866	
WA-7	8.28	2.504	20.73312	7	145.1318	80	1.814148	1.176282
pre-WA-8	4.36	2.244	9.78384	7	68.48688	75	0.913158	
WA-8	4.3	3.158	13.5794	7	95.0558	75	1.267411	0.354252
pre-WA-9	4.57	3.234	14.77938	7	103.4557	66	1.56751	
WA-9	19.4	1.228	23.8232	7	166.7624	66	2.526703	0.959193
pre-WA-10	3.31	2.026	6.70606	7	46.94242	86	0.545842	
WA-10	10.4	2.392	24.8768	7	174.1376	86	2.024856	1.479014
pre-WI-11	1.11	2.944	3.26784	7	22.87488	123	0.185975	
WI-11	37.6	1.867	70.1992	7	491.3944	123	3.995076	3.809102
pre-WI-12	19.4	0.614	11.9116	7	83.3812	100	0.833812	
WI-12	14	1.105	15.47	7	108.29	100	1.0829	0.249088
pre-WI-13	5.68	1.318	7.48624	7	52.40368	82	0.639069	
WI-13	53.8	2.385	128.313	7	898.191	82	10.95355	10.31448
pre-WI-14	1.78	3.946	7.02388	7	49.16716	159	0.309227	
WI-14	10.5	4.185	43.9425	7	307.5975	159	1.934575	1.625348
pre-WI-15	3.19	2.463	7.85697	7	54.99879	84	0.654748	
WI-15	10.2	3.017	30.7734	7	215.4138	84	2.56445	1.909703

a/ Fifteen workers, five from Florida (FL), five from Washington (WA) and five from Wisconsin (WI) are listed. For each worker, the 24-hour pre-exposure sample is listed first, followed by the 24-hour exposure sample for the same worker.

b/ p-NP - measured concentration of paranitrophenol in the pooled, collected urine for that 24-hour period as given in the study reports.

c/ The total volume of urine collected in that 24-hour period as listed in the study reports.

d/ In order to convert the amount of paranitrophenol collected during the 24-hour period to the amount of methyl parathion, the total p-NP is multiplied by the ratio of the molecular weight of methyl parathion to the molecular weight of the metabolite, paranitrophenol, and divided by the fraction of paranitrophenol (0.27) which comes out in the urine of humans within 24 hours of exposure to methyl parathion.

e/ Estimated equivalent amount of methyl parathion collected in the 24-hour period.

f/ Methyl parathion exposure (estimated absorbed dose per kg body weight).

g/ Corrected methyl parathion for each worker, the pre-exposure MP is subtracted from the post-exposure MP to yield the corrected absorbed dose.

Appendix II:

Subsets from Pesticide Handlers Exposure Database (PHED) for Handlers

Scenario: M/L, Open System, Liquids (With Gloves)

Table II-1. Description of PHED subsets for Mixer/Loader Scenario[a]

Parameter	Specifications used to generate subsets [a]	Actual characteristics of resulting subsets
Data Quality Grades[b]	A,B	A,B
Liquid Type	Emulsifiable concentrate, aqueous suspension, microencapsulated, solution, or undiluted liquid	Emulsifiable concentrate, solution
Mixing Procedure	Open	Open

a/ Subsets of Mixer/Loader data in the Pesticide Handlers Exposure Database (PHED). Parameter descriptions are from screens displayed in the PHED program.

b/ Data quality for Dermal Uncovered, Dermal Covered and Airborne are all Grade A or B; Hand data are all Grade A. Data quality grades are defined in the text and in Versar (1992).

Figure II-1. Summary of results from the Pesticide Handlers Exposure Database (PHED) dermal subset for Mixer/Loader Scenario[a]

SUMMARY STATISTICS FOR CALCULATED DERMAL EXPOSURES

SCENARIO: Long pants, long sleeves, gloves

PATCH LOCATION	MICROGRAMS PER LB AI MIXED Mean	Coef of Var	Geo. Mean	Obs.
HEAD (ALL)	127.9871	495.5875	4.1314	122
NECK.FRONT	23.0158	362.6609	1.7263	104
NECK.BACK	15.5714	383.462	.5412	110
UPPER ARMS	157.6735	903.2036	1.4925	90
CHEST	19.0359	263.976	3.4214	90
BACK	10.8933	223.0206	1.8685	89
FOREARMS	4.4266	211.9821	.8927	84
THIGHS	16.6064	198.1742	3.9823	72
LOWER LEGS	37.8101	824.4477	1.1046	82

Subset Name:
S5DERMAL.MLOD

a/ Subset criteria included actual and estimated head patches. Of the 122 head observations, 96 were actual and 26 were estimated from nearby patches (Versar, 1992).

Table II-2. PHED Data from Dermal, Hand, and Inhalation Subsets for Mixer/Loader Scenario[a]

Exposure Category	Exposure (µg/lb AI handled)	Replicates in subset	Short-Term Multiplier[b]	Long-Term Multiplier[b]
Dermal (non-hand)[c]	433	90[d]	4	1
Hand (with gloves)	58.2	59	4	1
Inhalation	2.35	85	4	1

a/ Results from subsets of Mixer/Loader data in the Pesticide Handlers Exposure Database (PHED). Results rounded to three significant figures.

b/ Multipliers are explained in the text and in Frank (2007).

c/ Dermal total includes addition of default feet value of 0.52 x (value for lower legs); ratio of feet/lower leg surface area (U.S. EPA, 1997).

d/ Median number of replicates was used in determining subset multipliers.

Table II-3. Values Used in Mixer/Loader Scenario Exposure Calculations [a]

	Short-Term Exposure	Long-Term Exposure
Total Dermal	4(43.3)[b] + 4(58.2) = 406 µg/lb AI handled	1(43.3) + 1(58.2) = 102 µg/lb AI handled
Inhalation	4(0.2) = 0.8 µg/lb AI handled	1(0.2) = 0.2 µg/lb AI handled

a/ Values from Table 5-2. Results rounded to three significant figures.

b/ Dermal exposure reduced 90% by label required personal protective equipment - coveralls over long sleeved shirt and long pants, waterproof gloves, chemical-resistant footwear and socks, protective eyewear, and chemical-resistant headgear.

Scenario: Pilots, Liquids, Open Cockpit

Table II-4. Description of PHED Subsets for Pilot Scenario[a]

Parameter	Specifications used to generate subsets [a]	Actual characteristics of resulting subsets
Data Quality Grades[b]	A,B,C	A,B,C
Liquid Type	Not specified	All emulsifiable concentrate
Solid Type	Exclude granular	None
Application Method	Fixed- or rotary-wing	All fixed-wing
Cab Type	Open Cab or Closed Cab with Open Window	Open Cab or Closed Cab with Open Window

a/ Subsets of Applicator data in the Pesticide Handlers Exposure Database (PHED). Parameter descriptions are from screens displayed in the PHED program.

b/ Data quality for Dermal Uncovered, Dermal Covered, and Hand were Grade A or C; Airborne data were Grade B or C. Data quality grades are defined in the text and in Versar (1992).

Figure II-3. Summary of results from the Pesticide Handlers Exposure Database (PHED) subset for Pilot Scenario [a]

SUMMARY STATISTICS FOR CALCULATED DERMAL EXPOSURES
SCENARIO: Long pants, long sleeves, gloves

PATCH LOCATION	MICROGRAMS PER LB AI SPRAYED Mean	Coef of Var	Geo. Mean	Obs.
HEAD (ALL)	4.212	118.2574	1.2438	10
NECK.FRONT	.414	143.6715	.1169	10
NECK.BACK	.3124	139.1485	.0741	10
UPPER ARMS	8.5554	109.6232	5.7532	10
CHEST	6.3065	158.1987	2.1395	17
BACK	8.7497	141.5614	3.131	17
FOREARMS	2.7901	131.7516	1.1744	17
THIGHS	9.55	157.4126	3.4718	13
LOWER LEGS	7.4494	138.0769	3.3312	10

Subset Name:
S17DERMAL.APPL

a/ Subset criteria included actual and estimated head patches. Of the 10 head observations, 7 were actual and 3 were estimated from nearby patches (Versar, 1992).

Table II-5. PHED Data from Dermal, Hand, and Inhalation Subsets for Pilot Scenario[a]

Exposure Category	Exposure (µg/lb AI handled)	Replicates in subset	Short-Term Multiplier[b]	Long-Term Multiplier[b]
Dermal (non-hand) [c]	5.2 [d]	10 [e]	6	2
Hand (with gloves)	9.63	9	6	2
Inhalation	0.573	14	5	2

a/ Results from subsets of Applicator data in the Pesticide Handlers Exposure Database (PHED). Results rounded to three significant figures.

b/ Multipliers are explained in the text and in Frank (2007).

c/ Dermal total includes addition of default feet value of 0.52 x (value for lower legs); ratio of feet/lower leg surface area (U.S. EPA, 1997).

d/ Dermal exposure reduced 90% by label required personal protective equipment- coveralls over long sleeved shirt and long pants, waterproof gloves, chemical-resistant footwear and socks, protective eyewear, and chemical-resistant headgear.

e/ Median number of replicates was used in determining subset multipliers.

Table II-6. Values Used in Pilot Scenario Exposure Calculations[a]

	Short-Term Exposure	Long-Term Exposure
Total Dermal (with gloves)	6(5.2) + 6(9.63) = 88.8 µg/lb AI handled	2(5.2) + 2(9.63) = 29.6 µg/lb AI handled
Total Dermal (no gloves)[b]	6(52.2) + 60(9.63) = 891 µg/lb AI handled	2(52.2) + 20(9.63) = 297 µg/lb AI handled
Inhalation	5(0.573) = 2.86 µg/lb AI handled	2(0.573) = 1.15 µg/lb AI handled

a/ Values from Table 17-2. Results rounded to three significant figures.

b/ Gloves assumed to provide 90% protection (Aprea *et al*, 1994); exposure of bare hands is calculated as ten times exposure of gloved hands.

Scenario: Airblast Applicators, Open Cab

A recent study involving the efficacy of protective headgear for airblast applicators riding in open cabs and applying carbaryl indicated a significant reduction in dermal exposure(Smith, 2005). The 95th percentile of short-term exposure wearing chemically protective headgear, chemically resistant gloves, long-sleeve shirt, long pants, shoes and socks was 277µg/lb a.i. handled, compared to 2,580 µg/lb a.i. handled for those without headgear. The long-term, average exposure for those same applicators was 73.7µg/lb a.i. handled for those with headgear, and 696µg/lb a.i. handled for those without headgear. However, the label for methyl parathion also specifies that applicators must also wear coveralls and a dust/mist filtering respirator. These items add additional protection that needs to be taken into account. Examination of the PHED database indicates that 77% of the exposure of airblast applicators using open cab tractors was due to head exposure. It was assumed that the additional PPE would reduce the exposure of the rest of the body by 90% (Table 10).

Table II-10. Effect of Label Required PPE on Short-Term and Long-Term Exposure of Airblast Applicators in Open Cabs.

Duration of Exposure	Amount of Exposure[a] (µg/lb a.i. handled)	Non-Head Exposure[b] (µg/lb a.i. handled)	Reduced Levels of Non-Head Exposure[c] (µg/lb a.i. handled)	Reduced Total Exposure[d] (µg/lb a.i. handled)
Short Term	277.0	63.7	6.4	220.0
Long Term	73.7	17.0	1.7	58.4

a/ The 95th percentile of short-term exposure wearing chemically protective headgear, chemically resistant gloves, long-sleeve shirt, long pants, shoes and socks was 277µg/lb a.i. handled; and the long-term, average exposure for those same applicators was 73.7µg/lb a.i. handled (Smith, 2005).
b/ 23% of column "Amount of Exposure ".
c/ 10% of column "Non-Head Exposure".
d/ Column "Amount of Exposure " minus column "Non-Head Exposure" plus column "Reduced Levels of Non-Head Exposure".

Appendix III:

Response to Review Comments from the Office of Environmental Health Hazard Assessment (OEHHA)